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Faculty office buildings as work environments: Spatial configuration, social interaction, collaboration and sense of community

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Abstract:
We aim to identify the role of spatial configuration in the social interaction, collaboration and sense of community at academia. We focus on the spatial configuration of three school buildings used by three different departments within the campus of a university in Izmir and utilize both spatial and social data. We have analyzed spatial data by Visual Graph Analysis (VGA) and searched for the spatial integration of the buildings with different plan typologies, but all have cell-based office configuration, which constitute linear plans with atrium, L-shaped and square with repeating floor plans. Social data is gathered by a questionnaire survey that is conducted with faculty members enquiring their office location in relation to spatial integration, sense of community, interaction and collaboration. We use correlation and regression analyses for the analyses of social data. Findings suggest that collaboration is independent of the plan typology but spatial integration promotes interaction and sense of community.

Keywords: *Work spaces, space syntax, social interaction, collaboration, sense of community.*

1. Introduction

Since the first establishment of office buildings in the 16th Century, the nature of work environment has been changing in accordance with the socio-economic changes in the World (McGregor and Then, 1999). Globalization and technological advances are encouraging the development of alternative distributed work environments such as virtual offices, home offices and hostelling (Hinds and Kiesler, 2002). Despite the changes that seemingly increase the distributed work environments, physical work environments still play an important role on the way work is conducted. Literature on physical work environments agree that spatial properties have effects on the social

environment of the work environments and the way workers perform. These relationships are confirmed in the case of federal offices (Wineman and Adhya, 2007), private companies (Allen, 1977; Grajewski, 1993; Peponis *et al.*, 2007; Steen, 2009), social work services (de Arruda Compos), media corporations (Sailer, Budgen, Lonsdale, Turner and Penn, 2009), research and development facilities (Hillier and Penn, 1991; Serrato and Wineman, 1999; Sailer and Penn, 2009) and offices within the academia (Lansdale, Parkin, Austin and Baguley, 2011). Considering the recent research on various work environments, we will illustrate our discussion with the examples regarding the domain of academia and research environments.

2. Nature of work in academia

Today's knowledge society, which acknowledges knowledge as the new capital, considers offices as knowledge-work environments where mental processes occur rather than physical labor (Heerwagen, Kampschroer, Powell and Loftness, 2004). These environments require spaces to support interactions and concentrated work together (Hua, Loftness, Heerwagen and Powell, 2010). Research environments and faculty offices in universities are also knowledge producing environments. However, their nature of work and organization are different from the work environments that have routine tasks and can be defined as "organizations whose business is the production, application, or transformation of knowledge" (Peponis *et al.*, 2007, p.815). In these environments, there is a critical balance that the work environment facilitates between the possibilities of interaction, collaboration and sense of community (Sailer and Penn, 2009). Besides, autonomy and privacy are crucial for researchers since the nature of graduate research is highly personalized (Lansdale *et al.*, 2011). Within the structure of research environments, academics work in so many different disciplines and they produce scientifically and commercially high valued knowledge (Ipe, 2003). Considering the value of knowledge produced in the multidisciplinary environment of academia, sharing knowledge among academicians is important. Knowledge sharing occurs from through the interaction of professionals with different backgrounds based on two kinds of knowledge, which are tacit and explicit (Polanyi, 1962).

Explicit knowledge "can be expressed in words and numbers and shared in the form of data, specific formulae, product specifications, manuals, universal principles and so forth" (Takeuchi, 2001, p.319). It can be codified, stored and shared independently from space and time (Ipe, 2003). However, explicit knowledge is just the tip of the iceberg (Takeuchi, 2001). Below the waterline, the non-visible part of the iceberg is tacit knowledge. Tacit knowledge is subjective, non-codified and inherited by personal experience (Polanyi, 1966). It is hard to formalize and difficult to share when compared to explicit knowledge that is more objective, tangible, stored and transmitted (Takeuchi, 2001). Tacit and explicit knowledge are complementary with each other like in the iceberg metaphor and the new knowledge is created by the interaction of tacit and explicit knowledge (Takeuchi, 2001). Hence, two kinds of knowledge have equal importance to create new knowledge in academia. Explicit knowledge is more dominant in academia but scientific developments and performance can be increased with the effective sharing of tacit knowledge among academics (Tekeli, 2004).

Nonaka and Konno (1998) state that tacit knowledge is comprised of a cognitive dimension related to beliefs, ideas, values of an individual, and a

technical dimension such as know-how. Leonard and Insch (2005) proposed a third dimension for tacit knowledge in academia. They define this dimension as social dimension, which involves social interaction with others. Social interaction provides emotional and work related support among academics (Lansdale *et al.*, 2011). There are two kinds of interaction that work environments provide (Peponis *et al.*, 2007). The first one is planned interactions that are formal and scheduled. The second one is unplanned interactions, which are more informal, and they occur by movement and copresence in a space that influences face-to-face interactions and spontaneous gatherings. Some studies emphasize the importance of the unplanned interactions on tacit knowledge sharing (Ipe, 2003; Rashid, Kampschroer, Wineman and Zimring, 2006). Besides the importance of social interaction for sharing tacit knowledge relevant to academia, we argue that collaboration and sense of community are also crucial.

Collaboration involves two or more people working together over time to produce a joint product or other outcome (Heerwagen *et al.*, 2004). Frequent interactions are also important for collaboration to succeed (Hua *et al.*, 2010). In the context of this research, we accept work related social networks as collaboration that includes explicit knowledge produced by at least two researchers and as well as work that is not yet explicit such as co-lecturing and dissertation supporting etc., which has not yet resulted in publication. The explicit knowledge among academicians in universities is prioritized within the 'publish or perish' principle. Although co-authored publications have been increasing in academia, single-author publications still remain their prestige (Wagner-Döbler, 2001). In some countries, single-author publications provide more opportunities and are more rewarded compared to co-authored publications. For instance, in the case for Turkey author takes the full points for single-author publications. There is a decrease in points that publication brings to authors with the increase of the number of authors. As a result of the remaining prestige of single-author publications and the nature of the graduate research that is highly personalized, collaboration among researchers in academia are usually discouraged. However, collaboration is important for the effective transfer of non-codified tacit knowledge among academicians for scientific developments.

Sense of community is a feeling of belonging to a group in which members have the perception of similarity with others in terms of interdependence, fulfillment of needs and emotional connection (McMillian and Chavis, 1986; Sarason, 1974). Since the nature of academic research is highly personalized, it is important to feel sense of community for having both work related and informal social interactions in order to acquire tacit knowledge. These interactions stimulate collaboration among academics and collaboration makes easier to share tacit knowledge. In the context of this research, we focus on informal interactions for sharing tacit knowledge and acknowledge sense of community as its facilitator.

2.1 Studies on research environments

Recent studies on research environments mainly deal with the relationship between spatial configuration and its different interaction patterns. They concluded that spatial configuration affects movement and creates spatial behaviors such as copresence and encounter. These behaviors influence face-to-face interaction, informal communication, gatherings and collaboration among researchers. One group of studies focuses on the

relationship between space integration and interaction patterns (Hillier and Penn, 1991; Serrato and Wineman, 1999; Wineman, Kabo and Davis, 2009), and other group of studies focuses on the relationship between proximity of offices and interaction patterns (Kraut, Fussell, Brennan and Siegel, 2002; Lansdale *et al.*, 2011; Sailer and Penn, 2009).

Space integration means how easily a space can be reached compared to the other spaces in the spatial layout. In other words, it is related to the extent the space is well connected to the other spaces (Peponis and Wineman, 2002). Established with the publication of *The Social Logic of Space* (Hillier and Hanson, 1984), space syntax literature examines the degrees in which spatial integration influences movement and spatial behaviors. More integrated spaces are predicted to have the highest movement in the spatial layout. Studies dealing with space integration and interaction patterns have agreement on the likelihood of interaction patterns related to the integration of the layout. They report positive effects of spatial integration on interaction patterns such as informal communication and information exchange. For instance, Hillier and Penn (1991) examined the distribution of interaction patterns relative to movement in the two research laboratories. They observed that properties of spatial configuration affect movement, and communication increase between research groups who are closer to the spaces of movement. Similarly, Serrato and Wineman (1999), examined the relationship between spatial layout and communication among researchers in the two research and development facilities. They found a relation between communication patterns and integration of the layout. They state that researchers, who are linked to the integrated corridors, have more communication with each other. Wineman *et al.* (2009) studied the effects of spatial layout on collaboration in a professional school at the University of Michigan. They found that offices that are well integrated within the whole building provide greater likelihood of collaboration among academics by promoting communication.

Although researches dealing with space integration and interaction patterns have drawn similar conclusions, researches on the relationship between proximity of offices and interaction patterns come up with different results. Kraut *et al.* (2002) examined how proximity affect interpersonal interaction and makes collaboration easier in research environments. They found that physical proximity increases the likelihood of collaboration, since the researchers in offices next to each other have more chance to encounter and interact. On the other hand, Lansdale *et al.* (2011) investigated the impacts of changing the spatial layout from cellular to open plan on collaboration among graduate researchers in the department of Civil and Building Engineering in Loughborough University. They found that the change decreases face-to-face interaction and collaboration among researchers. Sailer and Penn (2009) explored the relationship between spatial configuration and organizational outcomes in a research institute. They stated that interaction patterns among researchers are independent from proximity and following different rationales such as sharing common field of study. Literature review revealed that the group of studies that focus on the relationship between proximity of offices and interaction patterns cannot conclude in similar results. On the other hand, the other group of studies focuses on the relationship between space integration in general and interaction patterns have similar conclusions.

Considering the human-space relationships in the knowledge-work

environments the major concern of this paper is on faculty office buildings and it evaluates the influences of different spatial organizations. The fundamental question regarding the tacit knowledge sharing in academia is whether the role of spatial organization is likely to be effective in social interaction, collaboration and sense of community. The purpose of analyses that involve spatial analysis and a survey research shall be to answer this question. This paper contributes to the related literature on the relations between spatial configuration and interaction patterns and fills the gap on the limited body of research that focus on the relationship among interaction, collaboration, sense of community, and spatial integration in academia.

3. Methodology

3.1 Participants and procedure

We focused on three buildings of three different schools within a university setting in Izmir. The university was established in 1992 and settled in a separate campus outside of the city of Izmir. We analyzed the Schools of Architecture, Chemical Engineering and Mechanical Engineering. All these buildings have different plan typologies, but all have cellular office configuration. Spatial and social data were collected simultaneously during the research. Since we want to compare the results of the analyses of spatial and social data, we chose the buildings that have different spatial organization but similar functions.

3.2 Questionnaire survey and analysis

The social data was collected by conducting a questionnaire survey to academics that have offices in three buildings. Content and face validity of the measure were achieved through expert reviews and a pilot study. Regarding the considerations of five experts in the field, the questionnaire items were edited and a pilot study was conducted with ten academics. After the feedbacks final questionnaire was developed. The questionnaire addressed individuals' perceptions on the configurational attributes of their work environments, relationship to communal spaces, perceived interaction and collaboration with other academics in their department and sense of community. The questionnaire consisted of two parts. Two questions in the first part were about academicians' report on the spaces that gave them the most opportunity to encounter and socialize in the buildings of their school. Second part included twenty items based on a five-point Likert scale ranging from one (strongly disagree) to five (strongly agree) and examined respondents' perceived collaboration, interaction, sense of community and their office integration within their departments (Table 1). The measures of office integration were proximity and accessibility. Since research work environments are power irrelevant, the control measure are not taken into consideration. The measures of collaboration, interaction, sense of community were synthesized from Rashid, Wineman and Zimring (2009), Wineman and Adhya (2007).

121 academics were requested to attend to the survey. We received 51 valid responses and the overall response rate was 42%. In order to examine the relationship between the perceived office integration and the other social variables, we conducted correlation analysis. After correlation analysis, we conducted regression analysis in order to test our hypothesis which we developed:

> H1. Office integration will be a significant predictor for sense of community, interaction and collaboration.

We should indicate that the measure of office integration was based on the survey index not on VGA. All statistical analyses were computed via Statistical Package for the Social Sciences (SPSS version 16) software.

Table 1. *Items of the questionnaire.*

First Part of the Questionnaire	
1	Please report that you have the most opportunity to run across with people in your building
2	Please report that you have the most opportunity to socialize with people in your building
Second Part of the Questionnaire	
Office Integration items	
3	I am satisfied with the proximity of my office to other offices.
4	I am satisfied with the proximity of my office to the social spaces in the school.
5	I am satisfied with the visual accessibility of my office to other offices.
6	I am satisfied with the visual accessibility of my office to the social spaces in the school.
7	I am satisfied with the aural accessibility of my office to other offices.
8	I am satisfied with the aural accessibility of my office to the social spaces in the school.
9	I can find spaces to socialize in the building which my office is in.
Interaction items	
10®	I wish I had much more communication with my colleagues.
11	I am satisfied with the number of people that I have communication within the department.
12®	Without the department e-mails I would not have had any information on colleagues' work.
13	I find opportunities to socialize with colleagues in the department.
14	I know about colleagues' work in the department.
Collaboration*items (*We accept work related social networks by at least two researcher and products which has not yet resulted in publication such as co-lecturing and dissertation supporting etc. as ***collaboration)***	
15	I collaborate with colleagues in the department on work that we choose together.
16	There are spaces for working together in the building that my office is in.
17®	I wish to collaborate more colleagues in the department.
18®	I wish I shared more about my studies with the colleagues in the department
Sense of community items	
19	I generally join all of the activities in the faculty whether it is formal or informal
20	I feel I am a part of a community in the department.
21	I think there is unity and solidarity in the department.
22®	I feel I am remote from many people and topics in the department.

3.3 Space syntax research and analysis

The spatial data was collected by means of space syntax research. Since

the studies of Professor Bill Hillier and his colleagues, space syntax has been a research environment that develops quantitative tools for spatial analysis and its visualization. Space syntax works with the comprehensive concept of space, either as built form or as open space, which occurs inside and between built structures. It focuses on the role of spatial organization on human behavior, analyses social meaning of the spatial organization and develops descriptions for configured spaces from urban plans to building floors (Bafna, 2003). It represents and quantifies the space and uses it as a variable for statistical analysis of observed behavior patterns (Penn, 2003).

VGA was conducted for analyzing the spatial data, which was first used by Braaksma and Cook (1980) in order to calculate visibility of various units by producing an adjacency matrix in the case of an airport layout. VGA analyses visual fields from different parts of the buildings' spatial layouts and compare these to calculate which locations give users more visual information and which give less. VGA examines the relationship of each spatial unit in the layout, measures integration in terms of the relationship of each spatial unit to the entire system and shows the areas with the highest visual integration that are the most attractive areas for communication and interaction. VGA can be used for both buildings and urban layouts (Desyllas and Duxbury, 2001). It gives high prediction for spatial integration by juxtaposing visibility and potential movement. Spatial layouts were analyzed with VGA to calculate spatial integration by using the software Depthmap.

4. Results

This section presents the results of the analyses of the Schools of Architecture, Chemical Engineering and Mechanical Engineering respectively. Table 2 displays the buildings with their near environment and their location in the campus. Tables 3, 8 and 9 present the results of the VGA and questionnaire survey by relating the spatial and social data for each case. The left columns of the each table show the plans of the floors. The middle columns show VGA results with gradations from darker to lighter grey in order to indicate shifts from low to high integration. The right columns show the spaces that gave the most opportunity to encounter and socialize based on the reports of academicians to the first part of the questionnaire.

4.1 The school of architecture

The School of Architecture consists of five buildings which are aligned to make a U shape around a plaza (Table 2). There is a view of the whole campus from its sloped site. 92 academics inhabit the five buildings. Block A has three floors and includes offices for academics, classrooms, conference rooms, a canteen and a stationer. Block B has three floors and includes architectural design studios. Block C has two floors and includes only the offices of lecturers. Block D is the atelier of the School of Architecture. Block E has three floors and includes offices for academics and administrative staff, classrooms, meeting rooms, service areas, a kitchenette and a bunker. Since the use of the Block E is very similar with the other cases chosen in this study, we chose it as one of the case studies in this research.

Table 3 relates the results of the analyses of the spatial data and social data for the Block E. In the Block E, the sub floor has offices for academics and administrative staff. The ground floor has an entrance space, offices, two meeting rooms, a classroom and a kitchenette. The first floor has a gallery

space, offices, a classroom and a meeting room. Academicians' offices in the Block E open directly to the circulation area which is in the general hall.

Table 2. *Site view of the campus and the buildings.*

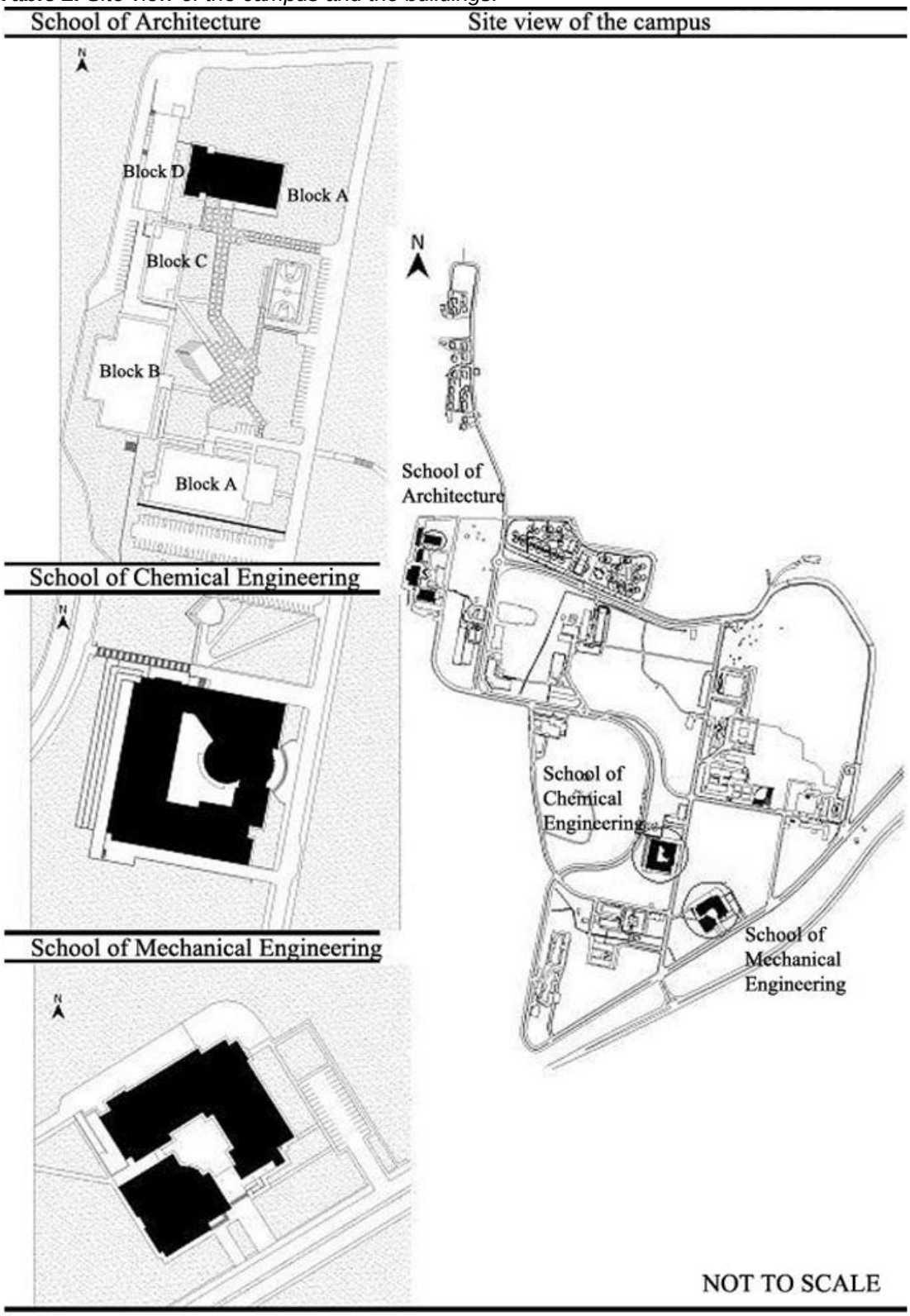
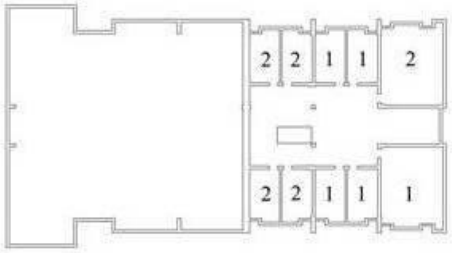
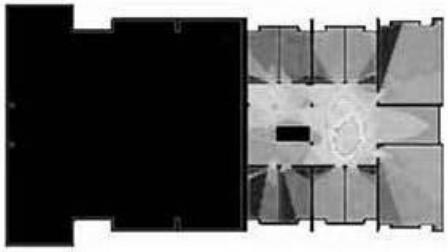
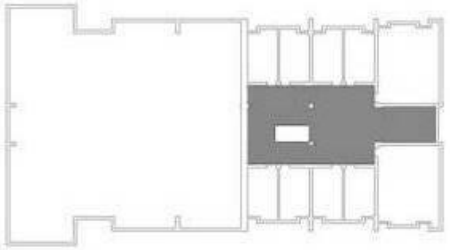
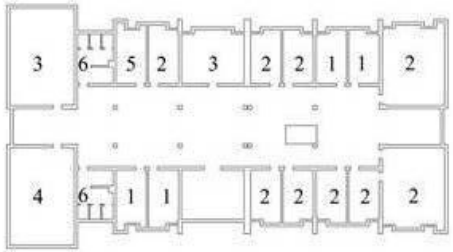
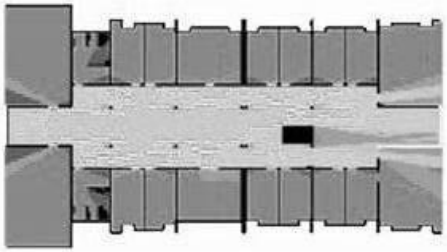
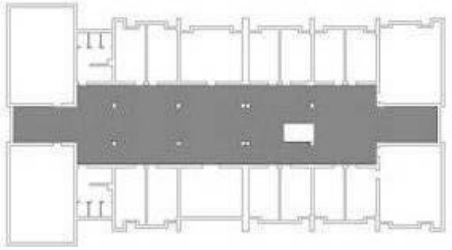
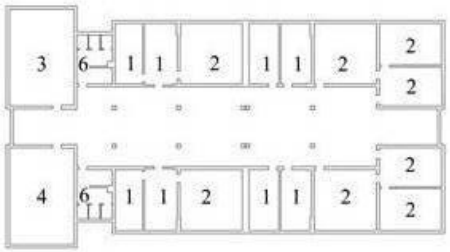
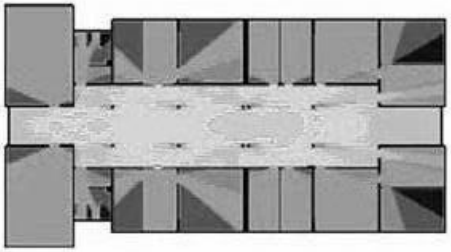
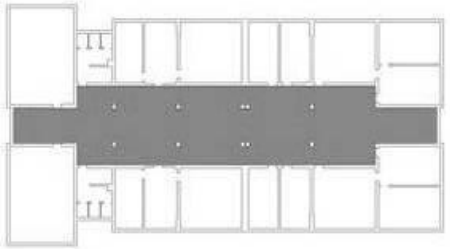


Table 3. *Comparison of the results of the questionnaire survey and space syntax research in the School of Architecture-Block E.*

	LAYOUT	VGA RESULT	QUESTIONNAIRE RESULT
Sub Floor			
Ground Floor			
First Floor			
Legend	1: Academician office 2: Administrative office 3: Meeting room 4: Classroom 5: Kitchenette 6: Service area	High Low	Spaces that give the most opportunity to encounter and socialize

The results of the VGA showed that the most integrated spaces of the whole building are at the general hall in front of the staircase on the sub floor, the west end part of the circulation area and around the staircase on the ground floor, in the middle of the general hall including staircase on the first floor. The degrees of integration are high to low from the centre to periphery on each floors of the building. On the ground floor, the most integrated space is shifted through the west end of the central circulation area since the staircase is blocking visibility. On the other hand, the integrated areas are dispersed and divided in two sides of the general hall on the first floor as a result of the absence of an obstacle that disallows visibility. On the sub floor, academicians' offices that are aligned to the longer side of the building show lower integration. However, the offices on the shorter side show higher integration compared to the ones on the longer side. This difference is a result of the fact that the offices on the longer sides on the sub floor are closer to the bunker and the doors of the offices on the east part have longer visibility. On the ground floor, the offices on the longer side of the building show higher integration compared to the offices on the longer sides of the sub floor since they have a longer visual field. The offices on the longer sides of the ground floor have equal integration levels. The offices on the shorter sides of the ground floor have the highest integration compared to the offices on each floor. All of the doors of the offices on each floor open directly to the general hall that includes the most integrated spaces but the doors of the offices on the shorter sides have longer visual fields covering the length of the building. The integrated spaces are dispersed through the offices on the shorter sides of the building of the ground floor as a result of the staircase that blocks the visibility from the general hall. Hence, the offices on the shorter sides are relatively more integrated rather than the offices on each floor. Besides, the offices on the longer sides of the building of the first floor have the highest integration among the offices on the other floors as a result of the alternative connections in between them. These connections allow accessibility between the offices and produce longer visual fields for the offices on the first floor.

Block E is occupied by 10 academics and the administrative staff of the School of Architecture. 8 academicians participated to the questionnaire survey and 2 of them discarded from the analysis for leaving blank sections. The response rate for Block E was 60%. We calculated the Coranbach's alpha (α) coefficient to determine the reliability of the measure and the result was reliable (α=0,809). Similar with the results of the VGA, the results of the first part of the questionnaire survey showed that spontaneous interactions and socializations occur mostly in spaces of circulation, which are also the central halls of the floors (Table 4 and Table 5). These spaces are colored in grey in the right column of the Table 3. The results of the correlation analysis showed that there is a positive correlation between the sense of community and office integration (Table 6, $r = 0,886$; $p \leq 0,05$). In order to test our hypothesis that more perceived office integration influences the outcome variables of interaction, collaboration and sense of community, we conducted regression analysis. Office integration emerged as a significant and positive predictor for sense of community, which partly aligns with our hypothesis. The independent variable office integration accounted for 78,5% of the variance in the dependent variable sense of community (Table 7).

Table 4. *Comparison of the results of the first question.*

The spaces that give academicians the most opportunity to run across with people	School of Architecture-Block E	School of Chemical Engineering	School of Mechanical Engineering
Circulation areas	**62%**	26%	13%
Canteen / Kitchenette	13%	**55%**	**52%**
Secretaryship	12%	7%	—
Offices	—	—	—
Meeting room	—	4%	—
Faculty Lounge	—	—	22%
Service area	13%	—	9%
Laboratories	—	4%	—
Open Atrium	—	—	—
Conference room	—	—	—
None	—	4%	4%
TOTAL	100%	100%	100%

Table 5. *Comparison of the results of the second question.*

The spaces that give academicians the most opportunity to socialize with people	School of Architecture-Block E	School of Chemical Engineering	School of Mechanical Engineering
Circulation areas	**37%**	15%	—
Canteen / Kitchenette	13%	**63%**	**68%**
Secretaryship	13%	—	—
Offices	25%	7%	—
Meeting room	12%	—	—
Faculty Lounge	—	—	27%
Service area	—	—	—
Laboratories	—	—	—
Open Atrium	—	4%	—
Conference room	—	4%	—
None	—	7%	5%
TOTAL	100%	100%	100%

***Table 6**. Correlation analysis results of the three schools.*

School of Architecture-E Block	
	Office Integration
Interaction	0,693
Collaboration	0,470
Sense of Community	**0,886***
School of Chemical Engineering	
	Office Integration
Interaction	**0,455***
Collaboration	0,364
Sense of community	0,245
School of Mechanical Engineering	
	Office Integration
Interaction	0,425
Collaboration	0,405
Sense of Community	**0,498***
*Correlation is significant at the 0,05 level	

4.2 The school of chemical engineering

The School of Chemical Engineering is a square shaped building which has two repeating floor plans and an open atrium in the middle. It has offices for academics and administrative staff, classrooms, laboratories, storages, service areas and a canteen. It is a mixed used building like the Block E of the School of Architecture. However, it has not any campus view like the Block E of the School of Architecture has as a result of its flat site in the campus plan. It is aligned to the vehicle roads and located close to the centre of the campus. Table 8 presents the floor plans of the School of Chemical Engineering and the results of VGA and the first part of the questionnaire survey. The use of the floors in the building is very similar. On both floors, there is a line of offices which are located facing the atrium and an outer line consists of classrooms and laboratories which are located facing outside the building.

Since the offices facing the atrium have wide windows that allow longer visibility distances, VGA is conducted in the opened window conditions of these offices on each floor. The results showed that the most integrated space in general is the atrium on each floor. Since the spaces located facing outside the building have shorter visibility distances, these spaces have lower integration levels compared to the spaces facing the atrium. For instance, academics' offices facing the atrium show higher integration compared to the offices which are located facing outside the building. Besides, among the offices facing outside the building the offices, which are closer to the service areas in the lower right side of the plan, have the lower integration when compared to the offices in the lower left side of the plan both on the ground and first floors. Since service areas disallow longer visibility distances and segregate these offices from the atrium, these offices are more segregated among the other offices both on the ground and first floors. Based on the VGA results we state that on each floor the most integrated space is the atrium, and the offices that are located facing the atrium show higher integration levels. In this case, VGA is resulted in difference with the results of the first part of the questionnaire survey (Table 8).

The School of Chemical Engineering inhabits 55 academics, 37 of whom participated in the questionnaire survey. The response rate was 68%. We calculated the reliability coefficient of the measure and the result was reliable (α=0,736). The first part of the questionnaire survey indicates that spontaneous interactions and socializations occur mostly in the canteen, and less frequently in the circulation area facing the atrium (see Table 4 and Table 5). Although this circulation area seems to be designed for a meeting and relaxation space, there are no chairs or tables to suggest stationary

activity inside it. That is why we think it does not stand out more than the other circulation areas. Correlation analysis of the second part of the questionnaire survey showed that there is a positive correlation between interaction and office integration (see Table 6, r = 0,455; p ≤ 0,05). Results of the regression analysis showed that office integration is a positive predictor only for interaction and accounted 20,7% of the variance (see Table 7).

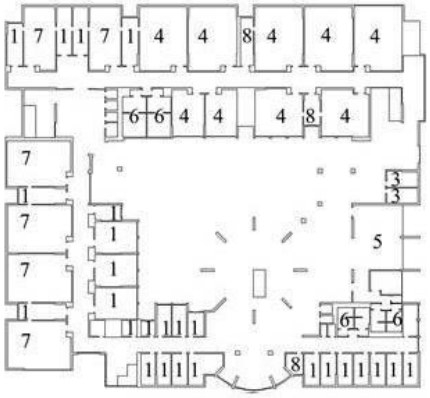
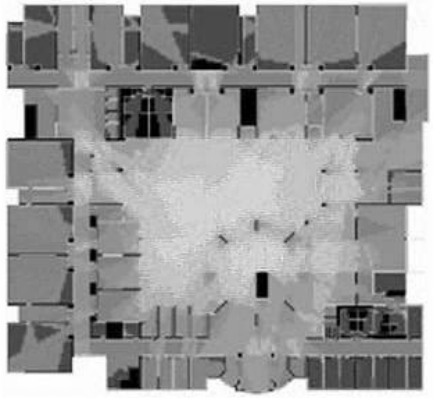
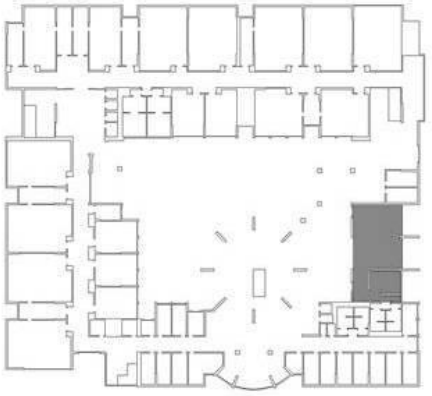
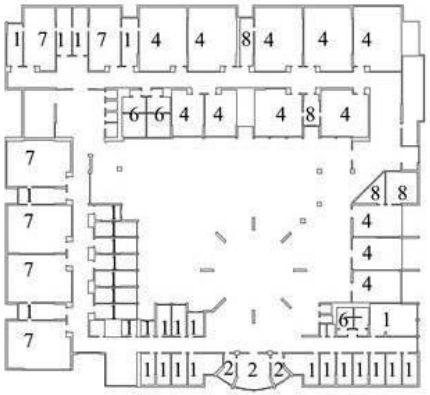
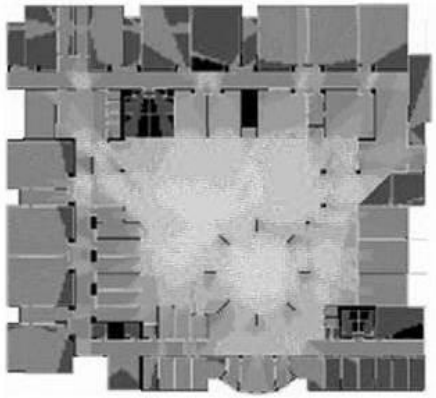
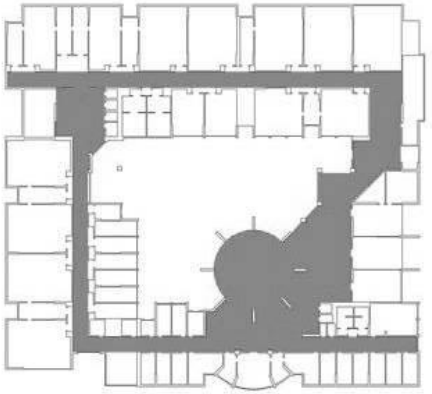
Table 7. *Regression analysis results of the three schools.*

School of Architecture-E Block				
	Independent Variable (X): Office Integration			
	R Square	Significance Level (*p*)	F	ß
Dependent Variable (Y): Sense of Community	0,785	**0,019***	14,603	0,688
Dependent Variable (Y): Interaction	0,480	0,127	3,693	0,570
Dependent Variable (Y): Collaboration	0,221	0,347	1,132	0,156
School of Chemical Engineering				
	Independent Variable (X): Office Integration			
	R Square	Significance Level (*p*)	F	ß
Dependent Variable (Y): Sense of Community	0,060	0,238	1,470	0,228
Dependent Variable (Y): Interaction	0,207	**0,022***	6,003	0,428
Dependent Variable (Y): Collaboration	0,133	0,074	3,516	0,220
School of Mechanical Engineering				
	Independent Variable (X): Office Integration			
	R Square	Significance Level (*p*)	F	ß
Dependent Variable (Y): Sense of Community	0,248	**0,025***	5,943	0,380
Dependent Variable (Y): Interaction	0,180	0,060	3,961	0,421
Dependent Variable (Y): Collaboration	0,164	0,076	3,537	0,276
*$p \leq 0,05$ Regression equation: $Y = ß_0 + ßX + \varepsilon$				

4.3 The school of mechanical engineering

The building of the School of Mechanical Engineering is mixed used like the other cases. However, it is aligned to the street in the southeast side of the campus and consists of an L-shaped and a square-shaped building, which are bordering a courtyard. Each of the buildings has two floors with similar uses on the ground and upper floors. The L-shaped building consists of offices for academics, classrooms, laboratories, service areas, an exhibition area and a canteen on the ground floor. On the first floor, there are offices for both academics and administrative staff, classrooms, laboratories, service areas and study rooms for small groups of researchers and students. The square-shaped building consists of offices for academics, service areas, a conference room and a rotunda with a human size chess board on the ground floor. On the first floor, there are offices for academics and administrative staff, a faculty lounge, a storage and service areas. Table 9 presents the floor plans, results of the VGA and the first part of the questionnaire survey.

Table 8. *Comparison of the results of the questionnaire survey and space syntax research in the school of chemical engineering.*

	LAYOUT	VGA RESULT	QUESTIONNAIRE RESULT
Ground Floor			
First Floor			
Legend	1: Academician office 2: Administrative office 3: Stationer 4: Classroom 5: Canteen 6: Service area 7: Laboratory 8: Storage	High Low	Spaces that give the most opportunity to encounter and socialize

VGA reveals that, in the L-shaped building the most integrated spaces in general are the circulation areas at the intersection of the corridors on the ground and the first floors. Larger spaces around the circulation area on the ground floor allow longer visibility. There is a canteen with the direct openings to the circulation area. The circulation area on the ground floor is more integrated compared to the first floor. All offices on the ground floor of the L-shaped building have very close integration with each other. However, the two offices close to the canteen on the ground floor are relatively more integrated since they offer longer visual fields. The offices on the first floor, which are aligned to the upper left corner of the plan, are segregated compared to the other offices. This difference is caused by the existence of study rooms blocking the view from the corridor and isolates them.

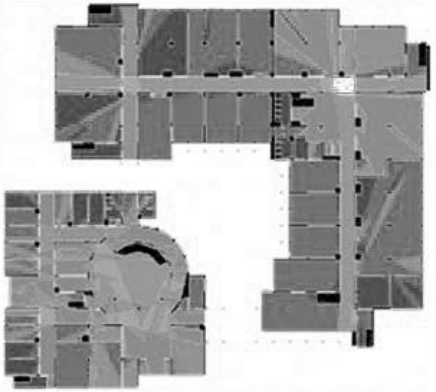
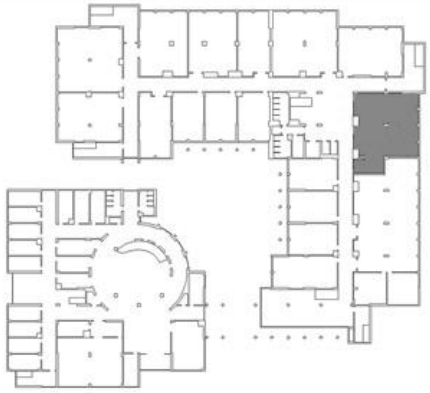
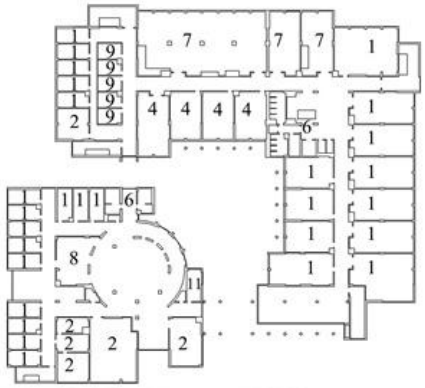
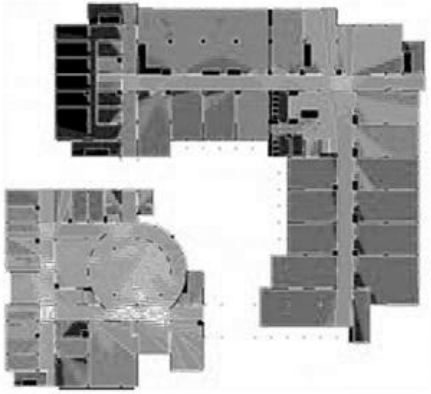
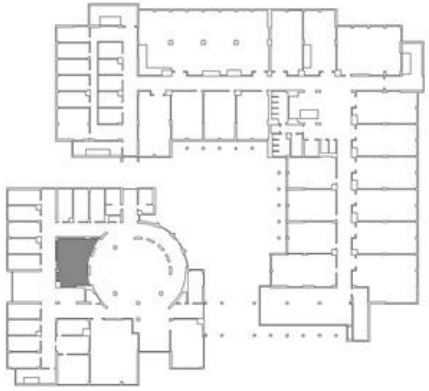
In the square-shaped building the rotunda and the circulation areas have the highest integration in general both on the ground and first floors. However, these spaces are more integrated on the first floor compared to the ground floor since the staircase on the ground floor disallows longer visibility distances. The offices on the first floor in the square-shaped building have higher integration than the offices on the ground floor as a result of the existence of faculty lounge on the first floor that allows longer visibility distances from rotunda to offices. VGA results of the School of Mechanical Engineering indicate that the most integrated spaces are the circulation areas at the intersection of the corridors around the canteen at the L-shaped building, and rotunda with circulation areas around the faculty lounge at the square-shaped building.

The School Mechanical Engineering inhabits 49 academics and 36 of them participated to the questionnaire survey. We found 20 of them as reliable and the response rate was 56%. We calculated the reliability coefficient and found measure as reliable (α=0,770). The first part of the questionnaire survey indicates similar results with the results of VGA. Spontaneous interactions and socializations occur mostly in the canteen located on the ground floor of the L-shaped building. Besides, on the first floor of the square-shaped building faculty lounge is where the most of the spontaneous interactions and socializations occur (see Table 4 and 5).The results of the correlation analysis showed that sense of community and office integration are correlated (see Table 6, $r = 0,498$; $p \leq 0,05$). Similar with the regression analysis results of the School of Architecture, office integration emerged as a positive predictor for sense of community in the School of Mechanical Engineering and it accounts 24,8% of the variance (see Table 7).

5. Conclusion

In the context of this research we analyzed the role of spatial integration as a spatial attribute in hindering or promoting social interaction, collaboration and sense of community in academia. We analyzed the three school buildings of a university setting which were all introverted. The first case was the Block E of the School of Architecture in which the central area inside the building was also the circulation area and offices opened directly to it. The second case was the building of the School of Chemical Engineering. It was square-shaped and its central hall was an open space, which allowed users to access it by passing another threshold after leaving their offices. The third case was the two buildings of the School of Mechanical Engineering that were bordering a courtyard, in which offices did not open directly to the courtyard. Among the all introverted cases, spatial configuration of Block E of the School of Architecture allowed everyone to access central area by just opening their offices.

Table 9. *Comparison of the results of the questionnaire survey and space syntax research in the school of mechanical engineering.*

	LAYOUT	VGA RESULT	QUESTIONNAIRE RESULT
Ground Floor			
First Floor			
Legend	1: Academician office 2: Administrative office 3: Conference room 4: Classroom 5: Canteen 6: Service area 7: Laboratory 8: Faculty lounge 9: Study room 10: Exhibition area 11: Storage	High Low	Spaces that give the most opportunity to encounter and socialize

Spatial analysis revealed that in the Block E the most integrated offices were on the ground and first floors. In the School of Chemical Engineering offices were located facing the atrium showed higher integration. In the School of Mechanical Engineering the most integrated offices were located at the intersection of the corridors on the ground and first floors of the L-shaped building and around the rotunda and circulation areas in the square-shaped building.

By means of the analysis of the social data, we found perceived office integration was correlated with perceived sense of community, but not with interaction and collaboration in the case of School of Architecture and Mechanical Engineering. However, in the School of Chemical Engineering we found perceived office integration was correlated with interaction. We found interesting that only the academics in the School of Chemical Engineering reported higher satisfaction of their offices' proximity and their interaction with others. With the exception for the School of Chemical Engineering, the results of the spatial analysis were similar with the reports of the academics about the spaces that give the most opportunity to encounter and socialize in their buildings. Hence, we expected that space integration and interaction would be correlated in the cases except the School of Chemical Engineering. We hypothesized the office integration would be a significant predictor of interaction, collaboration and sense of community. In all cases, the regression analysis partly confirmed our hypothesis. Both in the School of Architecture and School of Mechanical Engineering office integration emerged as a significant and positive predictor for the sense of community. The office integration accounts the 78,5% of the variance in the sense of community in the School of Architecture. However, office integration was a poor predictor for sense of community in the School of Mechanical Engineering by accounting 24,8% of the variance. In the School of Chemical Engineering, office integration emerged as a significant and positive predictor for interaction. In both cases, office integration was not directly related with collaboration and did not predict it. Configurational differences in school plans were not resulted in a considerable difference in terms of collaboration and we could not conclude that spatial integration promotes collaboration. Since the remaining prestige of co-authored publications and the nature of the graduate research depend on high autonomy, collaboration can be interpreted as being independent of the plan typology.

After reviewing the results, it is reasonable to conclude that the differences among the results of the cases can be resulted from the location of the buildings in the campus plan. For instance, in the case of Block E of the School of Architecture there is a view of the whole campus and the sea. Also, the School of Mechanical Engineering is located in the southeast periphery of the campus and aligned to the vehicle road which is also the entrance of the campus. Although the School of Chemical Engineering is located close to the centre of the campus, the view of the School of Chemical Engineering is blocked by the buildings positioned next to it. The School of Chemical Engineering does not have either a campus or a beyond-campus view that would bring global to the local. The views and the location of these buildings may be the reason of the spatial integration that promotes or hinders the sense of community and interaction. Since this research has not focused on the nature of interactions and collaborations, a nuanced examination can be made in the future through a qualitative work conducted with representative individuals and focus groups as well as

through a detailed network analysis. The results of the research do not suggest that a certain spatial organization would sustain and enhance interaction, collaboration and sense of community in academia. Despite this limitation, the analysis of the questionnaire survey give us a clue on the role of spatial configuration on a more psychological level that it affects the idea of virtual community in the global scale, since a considerable difference were related with the sense of community.

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Çalışma ortamı olarak fakülte ofis binaları: Mekansal organizasyon, sosyal etkileşim, işbirliği ve topluluk hissi

Bu çalışmada, mekânsal organizasyonun akademideki sosyal etkileşim (*social interaction*), işbirliği (*collaboration*) ve topluluk hissi (*sense of community*) üzerindeki rolü saptanmaya çalışılmıştır. Bu amaçla İzmir’de bir üniversitede bulunan üç farklı fakülte binasına odaklanılarak hem sosyal, hem de mekânsal veriler üzerinde çalışılmıştır. Mekânsal veriler, *Visual Graph Analysis* (VGA) kullanılarak analiz edilmiş ve avlulu, lineer planlı, L ve kare planlı olmak üzere farklı plan tipolojilerinde mekânsal entegrasyon hesaplanmıştır. Sosyal veriler, fakültelerdeki akademisyenlere düzenlenen ve akademisyenlerin ofis lokasyonlarının mekânsal entegrasyon, topluluk hissi, sosyal etkileşim ve işbirliği ile olan ilişkisini sorgulayan bir anket çalışması ile toplanmıştır. Sosyal verilerin analizi için korelasyon ve regresyon analizleri kullanılmıştır. Çalışmanın bulguları, işbirliğinin plan tipolojisinden bağımsız olduğunu, mekânsal entegrasyonun ise sosyal etkileşim ve topluluk hissi ile ilişkili olduğuna işaret etmektedir.